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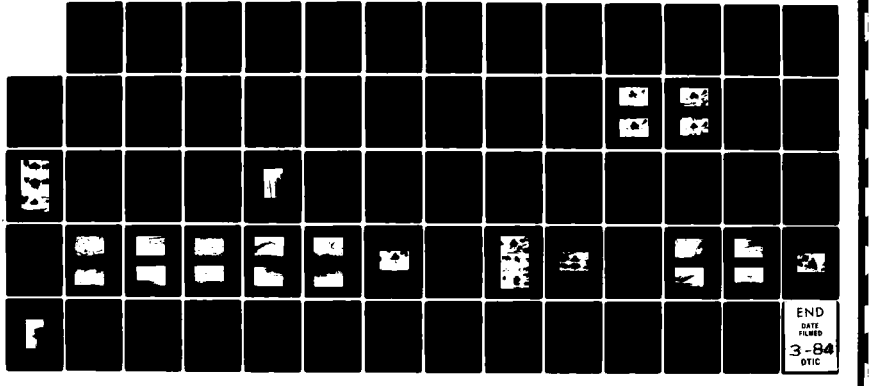

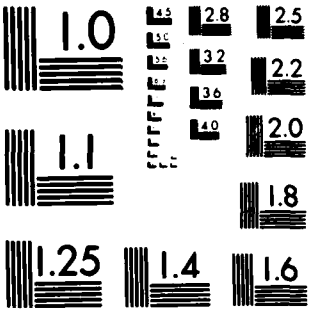

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EFFECTS OF AN AIR-POWDER ABRASIVE DEVICE WHEN USED DURING PERIODONTAL FLAP SURGERY IN DOGS

A THESIS IN
DEPARTMENT OF PERIODONTICS

Presented to the Faculty of the University
of Missouri-Kansas City in partial fulfillment of
the requirements for the degree

MASTER OF SCIENCE, ORAL BIOLOGY

by

WILLIAM EDWARD CROOKS

B.S., Mercer University, 1972
D.M.D., University of Florida, 1976

Kansas City, Missouri

1983

EFFECTS OF AN AIR-POWDER ABRASIVE DEVICE WHEN USED DURING PERIODONTAL FLAP SURGERY IN DOGS

William Edward Crooks, B.S., D.M.D., M.S.
University of Missouri-Kansas City, April, 1983

ABSTRACT

An air-powder abrasive system, the Prophy-Jet Model C-100, is a commercially available product intended for cleaning enamel tooth surfaces. A recent investigation has pointed out the potential use of this instrument for root preparation during periodontal surgery. The purpose of this research was to assess some of the effects of an air-powder abrasive system when used during periodontal flap surgery in dogs.

In the first part of the study, periodontal flap surgery was performed bilaterally. The Prophy-Jet was used for simulated root detoxification on one side, while the other side served as a control. A statistical analysis was performed comparing the inflammatory responses elicited. Use of the Prophy-Jet did not appear to cause any adverse effects on the post-operative healing in dogs. All dogs were judged clinically to be healing well bilaterally when sacrificed at 2, 4, 7, and 14 days. Histologically, significantly less inflammation was found on the experimental side at four days.

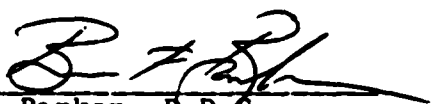
In the second part of the study, the possible

localized toxic effect of the Prophy-Jet powder was investigated. A forty milligram bolus of powder was placed under a periodontal flap. The placement of the bolus of powder resulted in ulceration and necrosis of a portion of the flap in over half of the animals. Evidence of increased inflammation was apparent histologically in all the dogs through day seven.

The third part of the study examined the possible damage which might occur if a periodontal flap were exposed directly to the Prophy-Jet spray. When the periosteal side of the periodontal flap was sprayed, tissue damage and increased inflammation were seen both clinically and histologically.

Future areas of research regarding the Prophy-Jet are discussed. Guidelines are offered for possible human experimentation in a surgical environment. The Prophy-Jet is a potential aid to the therapist treating the periodontium. Its use should be guided by the results of future research and good clinical judgment.

This abstract of about 275 words is approved as to form and content.



Bruce F. Barker, D.D.S.
Professor in charge of thesis

The undersigned, appointed by the Dean of the School of Graduate Studies, have examined a thesis entitled

EFFECTS OF AN AIR-POWDER ABRASIVE DEVICE WHEN USED DURING PERIODONTAL FLAP SURGERY IN DOGS

presented by WILLIAM EDWARD CROOKS, a candidate for the degree MASTER OF SCIENCE, ORAL BIOLOGY and hereby certify that in their opinion it is worthy of acceptance.

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DEDICATION

This thesis is dedicated to Dr. William J. Killoy and Dr. Hiram R. Fry, whose encouragement, guidance, and friendship have been richly rewarding.

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INTRODUCTION

Background Statement

The goal of periodontal therapy is the restoration and/or maintenance of a healthy, comfortable, and functional periodontium. Although there is disagreement as to the best method of reaching these goals, the removal of bacteria and their by-products from diseased root surfaces is perhaps the most universally accepted single modality of treatment (Garrett, 1977; Jones and O'Leary, 1978; Kakehashi and Parakkal, 1982).

Numerous techiques have been employed in an attempt to make the diseased root surfaces non-toxic, i.e. free of bacteria and their by-products. These techniques include: scaling and root planing with a variety of hand instruments, ultrasonic devices, air driven reciprocating handpieces, and air driven rotary handpieces (Schaffer, 1967). None of these techniques have been shown to be completely effective in the removal of bacteria and their products (Walker and Ash, 1976; Waerhaug, 1978; Thornton and Garnick, 1982). Incomplete removal of subgingival plaque has been stated to be equal to no plaque removal at all (Waerhaug, 1978).

The periodontal curette is generally considered to be the most effective means of detoxifying diseased root surfaces (Garrett, 1977; Nishimine and O'Leary, 1979).

Areas of residual untreated surface or microscopic grooves are still often seen even with use of curettes (Waerhaug, 1978). Root planing with curettes during periodontal surgery, when access to the diseased root surfaces is the best, is still a tedious and time consuming task. Root concavities, root proximity, osseous defects, and narrow furcations can cause root preparation to be incomplete. Evaluation of the furcation entrance diameter has indicated that over half of the furcation entrances are inaccessible because they are smaller than the blade width of commonly used periodontal curettes (Bower, 1979).

A recent investigation suggests a more efficient and effective method of root detoxification (Atkinson, 1982). An air-powder abrasive system, the Prophy-Jet Mark IV C-100[1], may be an alternative to conventional mechanical and chemical methods of detoxifying roots. The handpiece is controlled by a rheostat and directs particles of an abrasive powder through a pressurized stream of air and water creating a slurry. The abrasive powder is composed of sodium bicarbonate which has been treated with calcium phosphate tribasic to make it free-flowing.

Atkinson (1982) has shown that a thirty second continuous exposure to the abrasive slurry results in the

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[1]Prophy-Jet Model C-100, Cavitron Division of Cooper Medical Devices, Dentsply International, York, Pennsylvania, 17405.

removal of an average of 636.6 microns of root structure. A thirty second exposure was selected to simulate the amount of exposure which might take place in a patient on three month recall for fifteen years. The root surfaces were rendered "shiny smooth" with a uniformly smooth surface texture. Furthermore, no areas of residual untreated root surface or grooves were seen when the teeth were examined microscopically. The removal of over 600 microns of root structure far exceeds the amount necessary to effectively detoxify diseased root surfaces.

Because of its ability to rapidly remove root structure and treat areas inaccessable to curettes, the Prophy-Jet may have potential use for root detoxification during periodontal surgery. However, the effects of this system on surgically exposed tissues must be evaluated before its use in a surgical environment can be recommended.

Sodium bicarbonate is a white crystalline powder. It is a very soluble compound in water. It is used in the manufacture of many sodium salts, serves as a source of carbon dioxide in manufacturing, and is an ingredient in many cleaning compounds (Merck Index, 1976). Sodium bicarbonate has a variety of common household uses including use as an antacid. Recently sodium bicarbonate has been advocated as a dentifrice in combination with hydrogen peroxide as part of a therapeutic regimen for the treatment and/or prevention of periodontal disease (Keyes, Wright, and Howard, 1978).

Sodium bicarbonate may alter the post-surgical environment in a variety of ways. In the unlikely event a small quantity remained undissolved, a foreign body reaction might ensue. The ionization of this compound when in solution may alter the osmotic pressure of the extracellular fluid. This alteration of the extracellular osmotic pressure might in turn result in loss of intracellular fluid and dessication of cells. Since sodium bicarbonate is the salt of a weak acid, an increase in the bicarbonate ion concentration has the potential to elevate the pH of the extracellular and intracellular fluid. These potential effects of sodium bicarbonate could result in further tissue injury.

Calcium phosphate tribasic is an amorphous white powder which is practically insoluble in water, as only two milligrams will dissolve in 100 milliliters of cold water (Handbook of Chemistry and Physics, 1982-1983). It occurs in nature as the mineral, whitlockite, and is commercially prepared form phosphate rock. It is used in the manufacture of fertilizers and animal feeds. It is also used as a non-caking agent (Merck Index, 1976). More recently it has been used in the manufacture of bioceramics used for bone prosthetic applications (Jarcho, 1981). Although it only comprises a small fraction of the Prophy-Jet powder; the insolubility of calcium phosphate tribasic suggests that it may elicit a foreign body response.

The possible effects outlined above would most likely result in an increase in post-operative inflammation, both clinically and histologically. Inflammation is a necessary component of wound healing. The intensity of the inflammatory process following a surgical procedure is usually proportional to the degree of tissue injury (Guyton, 1981). The more intense the inflammatory response is, the more prolonged the healing process will be. If the use of the Prophy-Jet during periodontal surgery does, in fact, result in increased tissue injury, an increase in the inflammatory response would be expected.

To date two studies have been conducted on the effects of the Prophy-Jet and/or Prophy-Jet powder on soft tissues. The first was accomplished by deliberately exposing gingiva of dogs to direct three second bursts at a distance of four millimeters (Clinical Research Associates, 1981). Histologic examination revealed extensive soft tissue damage initially, but damage was unrecognizable after fifteen days. The second study used hamsters as the test animals (Toxigenics, Inc., 1982). One gram of the Prophy-Jet powder was applied to the buccal mucosa and then rinsed away after twenty minutes. The applications were repeated ten times over a two week period. The buccal mucosa was examined clinically and histologically and no differences were observed between the test sites and the negative control sites. Although these results are encouraging, the

studies did not simulate surgical conditions.

Problem Statement

The purpose of this study was to determine if the use of an air-powder abrasive device during periodontal flap surgery in dogs, would result in an altered post-operative inflammatory response or any clinically observable post-operative complications. A secondary purpose was to study the post-operative effects resulting after manual placement of the powder under a periodontal flap.

Hypothesis

If adult dogs have bilateral periodontal flap surgery and the experimental side is treated with an abrasive spray of air, water and powder, there will be no significant difference (alpha=.01) in inflammatory response between the two sides at 2,4,7, or 14 days post-operatively.

MATERIALS AND METHODS

Animal Model

As this study was the first to investigate the effects of the Prophy-Jet when used during periodontal flap surgery, an animal model was utilized. The mongrel dog was chosen as a sufficient number were readily available at minimal expense. The dog model has been used extensively in periodontal research. Specifically, Wilderman, Wentz, and Orban (1960); Lobene and Glickman (1963); Staffileno, Levy, and Gargiulo (1966); Hiatt, Stallard, Butler, and Badgett (1968); and Levin, Grower, Cutright, and Getter (1977), have utilized mongrel dogs to investigate the healing response to a variety of periodontal flap surgical techniques.

Fourteen dogs were acquired for this study. Thirteen were male and one was female, all were over eighteen months of age and considered to be in good health. Their weights ranged from 24 to 55 pounds. The animals were kept in separate cages in the same quarters and fed the same commercially available diet daily throughout the experiment. The dogs were identified by numbers tatooed on the underside of the ear.

Instrumentation

The Prophy-Jet Model C-100 air-powder abrasive system's recommended use has been limited to removal of plaque and stain from tooth enamel. It operates on a 115

volt electric current and uses inlet air pressure of 65 to 100 p.s.i. and inlet water pressure of 25 to 60 p.s.i. The handpiece propels particles of the Prophy-Jet powder through a stream of air surrounded by water creating a slurry. The powder is sodium bicarbonate, treated with tribasic calcium phosphate to make the powder free flowing. This treatment results in tribasic calcium phosphate comprising 0.5 percent of the powder (Brinkman, 1982). The powder has been sifted through a 200 mesh screen to eliminate particles larger than seventy-four microns (Crow, 1981).

The Prophy-Jet was adjusted and tested prior to each surgical session. The device was connected to a tank of compressed air and the pressure was adjusted to 65 p.s.i. by means of a regulator. A water line containing a pressure gauge was connected and the pressure adjusted to 40 p.s.i. The powder reservoir was filled according to manufacturer's instructions. The unit was switched on and the water flow was adjusted by a valve on the unit in order to achieve a two inch column of water as the tip was held pointing upward. An oxidized copper penny was sprayed with the air-powder abrasive, in order to insure that the Prophy-Jet was functioning properly. All the procedures and adjustments outlined above are in compliance with the manufacturer's recommendations.

Surgery and Treatment

Fourteen mongrel dogs underwent periodontal flap

surgery bilaterally in the mandibular arch. The dogs were anesthetized by intravenous injection of sodium pentobarbital at a dosage of thirteen milligrams per pound of body weight. Prior to incisions, 0.5 to 1.0 milliliter of two percent lidocaine with epinephrine 1:100,000 was injected below the mucogingival junction in the areas to be treated. The local anesthetic solution was utilized to more accurately mimic clinical practice and for control of hemorrhage. All flaps were elevated from the buccal aspect and were full-thickness mucoperiosteal flaps. No lingual flaps were elevated. After the various treatments described below were administered, all flaps were replaced, sutured interproximally with 4-0 silk, and finger pressure was applied for five minutes.

Part I: Simulated Root Detoxification

Vertical incisions were made at the distal line angle of the first premolar and the mesial line angle of the third premolar. A sulcular incision was then made connecting the vertical incisions. A mucoperiosteal flap was elevated from the buccal aspect of the second premolar and reflected apically to the mucogingival junction (Fig. 1). All visible hard and soft deposits were removed from the tooth with a scaler (Fig. 2). This same procedure was accomplished on the opposite side of the arch. The left or right side was randomly selected, by coin toss, to serve as the control. The control side flap was then replaced,

Fig. 1. Reflection of mucoperiosteal flap as described in Part I.

Fig. 2. Visible deposits removed from tooth (Part I).

Fig. 3. Prophy-Jet in position to begin spraying (Part I).

Fig. 4. Flap replaced and sutured after simulated root detoxification (Part I).

sutured, and pressure applied as previously described. The experimental side was treated with the Prophy-Jet. The tip was held four to six millimeters from the tooth surface and the spray directed at the root surface just above the alveolar crest (Fig. 3). The tip was slowly moved from the mesial line angle to the distal line angle and back. The buccal surface was sprayed for twenty seconds, as timed by an assistant. The area was not rinsed. The flap was replaced, sutured and pressure applied (Fig. 4).

The results of a pilot study roughly based on the above stated methodology resulted in little difference between the experimental and control either clinically or histologically. The original protocol was therefore expanded to investigate the effects of potential abuse of the Prophy-Jet system. The procedures described below were conducted during the same surgical session as those of Part I.

Part II: Placement of a Bolus of Powder

A sulcular incision from the midfacial of the first molar to the midfacial of the third premolar was made on the buccal aspect of the experimental side. A mucoperiosteal envelope flap was elevated to the mucogingival junction over the fourth premolar (Fig. 5). All hard and soft deposits were removed from the tooth with a scaler. Forty milligrams of the previously described powder provided with the Prophy-Jet was placed on the alveolar bone over the fourth premolar (Fig. 6). The flap was immediately

Fig. 5. Reflection of mucoperiosteal "envelope" flap as described in Part II.

Fig. 6. Placement of 40 milligram bolus of Prophy-Jet powder under the flap (Part II).

Fig. 7. Flap replaced and sutured (Part II).

replaced and sutured, and pressure applied for five minutes (Fig. 7). All fourteen dogs received this treatment.

Part III: Spraying of the Soft Tissue Flap

On the side which had been previously designated as the control side, vertical incisions were made on either side of the fourth premolar and a sulcular incision was made connecting the vertical incisions. A mucoperiosteal buccal flap was elevated to the mucogingival junction. The periosteal side of the flap was sprayed with the Prophy-Jet at a distance of six millimeters for five seconds. The Prophy-Jet was moved from mesial to distal during the five second spray. The flap was replaced, sutured, and pressure applied for five minutes. Only one dog from each group destined for sacrifice at 2, 4, and 7 days after surgery received this treatment.

Clinical Evaluation

The dogs were sacrificed at 2, 4, 7, and 14 days after treatment. At the time of sacrifice all dogs were evaluated by clinical observation. The observations were made by two clinicians, one of whom was unaware of which tooth was the control. Areas demonstrating necrosis, ulceration, pronounced erythema, or any other obvious differences were noted and clinical photographs were taken.

Tissue Preparation

The dogs were sacrificed by an intracardiac injection of ten milliliters of National Laboratories T-61 euthanasia

solution. The experimental and control teeth were removed in block section and fixed in ten percent buffered formalin solution. After fixation and removal of the crowns, the blocks were placed in American Scientific Products Decalcifying Solution for seventy-two hours. Bucco-lingual sectioning was done in order to obtain tissue from the mesial or distal root. The furcation area was avoided in order to obtain better orientation for microscopic analysis. The tissue samples were embedded in paraffin and sectioned at a thickness of five microns. Twelve sections were made skipping an interval of twenty microns after every fourth section. The sections were then processed and stained with hematoxylin and eosin.

Data Collection

Part I

All sections were screened using light microscopy at 25X magnification. From those sections judged to be of good quality, one section was randomly selected to represent each tooth.

Histometric analysis was accomplished using light microscopy at 25X magnification and a ten millimeter ocular grid. The grid was divided by one millimeter increments and therefore contained 100 squares of equal size. The slide was positioned so that the grid was overlying the soft tissue of the buccal flap previously reflected. The lateral border of the grid was positioned parallel to and

just touching the alveolar bone. The grid was further positioned so that thirty percent of the grid was above the alveolar crest and seventy percent was below the alveolar crest (Fig. 8).

The area of connective tissue within the grid was quantified by counting the squares in which connective tissue filled fifty percent or more of the square. After the connective tissue was quantified, it was evaluated for inflammation. Any of the previously counted connective tissue squares, in which inflammatory cells and/or fibrin filled fifty percent or more of the square, were considered inflamed. These squares of inflammation were counted and divided by the total number of connective tissue squares to arrive at the percentage of area inflamed. These counts were done by two examiners independently and their results averaged. When evaluating the slides the examiners were unaware which were experimental and which were control. During the quantification of inflammation both examiners occasionally used higher magnifications up to 400X in order to confirm the presence or absence of inflammation in a given area.

The examiners had previously been calibrated for inter-examiner reliability using ten sections not included in the study. The mean absolute difference between the percentages of area inflamed scored by the examiners during this calibration was 1.7. A Pearson product-moment correlation

Fig. 8. Low power photomicrograph of a typical buccolingual section. Square represents the area which was placed under the ocular grid (Part I). Original magnification is 10X.

coefficient was calculated (r=0.97).

Further evaluation was accomplished by both examiners concurrently using a multiple viewing microscope. At 25X magnification the inflammation at the crevice was characterized, the number of resorptive lacunae in bone were counted, inflammation within bone was characterized, and foreign bodies detected with polarized light were counted. At 400X magnification with the ocular grid in place, an area of inflammation, deemed characteristic, was centered under the grid. Ten squares were randomly selected and the following cell types were counted within those ten squares; lymphocytes, plasma cells, macrophages, and polymorphonuclear leukocytes.

Part II and Part III

Since these procedures were not part of the originally conceived experiment, the analysis of Part II and III was only descriptive in nature. One representative section of good quality for each tooth was evaluated concurrently by both examiners. The evaluation was similar to that of Part I, except the amount of inflammation was not quantified. A short narrative containing the elements in the descriptive portion of Part I was written for each tooth. Control teeth of Part I were utilized as a frame of reference for evaluation.

Data Analysis

The percentage of area inflamed (PAI) scores determined in Part I were subjected to statistical analysis. A two-factor (one between subjects factor and one within subjects factor) repeated measures statistical design with associated analysis of variance was used to determine an appropriate error term for the Tukey Multiple Comparison Technique. Pair-wise comparisons between control and experimental mean PAI scores at each of the time intervals was made with this technique (alpha=.01).

RESULTS

One of the fourteen dogs died during the evening of the day of surgery. This death can not be explained with certainty but was assumed to be related to the intravenous anesthesia. No data was obtained from this dog.

Part I: Simulated Root Detoxification

Clinical Evaluation

No clinical differences were seen between the control and the experimental gingival tissue in any dog. No area of ulceration, necrosis, or severe erythema was seen. The tissues were adapted well about the teeth in all cases and no area of recession was noted. All dogs appeared to be healing well bilaterally. The dogs examined at two days post-operatively had moderate erythema at the gingival margin and along the lines of incision. Slight edema was also noted. These features were evident about both the control and experimental teeth. Similar findings were noted in the dogs examined at four and seven days but to a progressively lesser extent. No clinical signs of inflammation were seen in the dogs examined at fourteen days post-operatively nor were the incision lines visible.

Histometric Analysis

The percentage of area inflamed (PAI) scores for each tooth examined is listed in Table 1. The general trend was for the inflammation to diminish with time. The exception

TABLE 1

PERCENTAGE OF AREA INFLAMED (PAI) SCORES
AND MEAN SCORES FOR EACH TIME INTERVAL

SACRIFICE TIME	DOG #	CONTROL	EXPERIMENTAL
2 Days	1	22.6	13.8
	2	16.4	12.8
	3	18.0	19.1
	Mean	19.0	15.2
4 Days	4	32.1	8.4
	5	32.9	11.8
	6	7.9	7.6
	Mean	24.3	9.3
7 Days	7	9.2	3.5
	8	11.1	9.5
	9	4.2	0.0
	Mean	8.2	4.3
14 Days	10	6.0	0.0
	11	0.0	3.6
	12	0.0	0.0
	13	0.0	0.0
	Mean*	2.0	1.2

*Dog #13 was randomly selected for exclusion in statistical analysis in order to have equal numbers in each group.

to this trend was seen in the control groups where inflammation increased from day two to day four. It should be noted however, that it was in the four-day control group where the most variance among dogs occurred. The scores in this group ranged from 7.9 to 32.9. By seven days inflammation was minimal and by fourteen days was virtually absent on both control and experimental sides.

There was a tendency for the PAI scores to be slightly lower in the experimentally treated areas than in the contralateral control areas. Only two of the thirteen animals had more inflammation on the experimental side. These differences in PAI scores were slight except in two dogs of the four-day group.

A statistical comparison of the mean PAI scores for each of the four time intervals is presented in Table 2. Dog #13 was randomly selected to be excluded from the fourteen-day group in order to meet the requirements of the Tukey Multiple Comparison Technique by having equal numbers in each group. The only significant difference was found in the four-day group where the mean for the control sides was greater than the experimental mean.

Table 3 gives the proportion of the inflammatory cell-types present at the various time intervals. The proportion of polymorphonuclear leukocytes is highest at two to four days. The four-day control group has the highest proportion of PMN leukocytes (.81) and this is consistent with

TABLE 2

COMPARISON OF THE MEAN PAI SCORES
AT EACH TIME INTERVAL

SACRIFICE TIME	CONTROL	EXPERIMENTAL	C - E
2 Days	19.0	15.2	3.8
4 Days	24.3	9.3	15.0*
7 Days	8.2	4.3	4.0
14 Days	2.0	1.2	0.8

*Significant (alpha=.01) Tukey Multiple Comparison Technique.

TABLE 3

PROPORTION OF INFLAMMATORY CELL TYPES OBSERVED AT EACH TIME INTERVAL IN PART I

CELL TYPE	2 DAYS		4 DAYS		7 DAYS		14 DAYS	
	C	E	C	E	C	E	C	E
PMN Leukocytes	.46	.63	.81	.37	.07	.09	.00	.00
Plasma Cells	.02	.01	.00	.00	.05	.04	.12	.00
Lymphocytes	.36	.20	.15	.47	.45	.47	.53	.69
Macrophages	.16	.16	.04	.16	.43	.40	.35	.31
Totals	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

the mean PAI score for this group. With time, the proportion of PMN leukocytes decreased as the proportion of lymphocytes and macrophages increased. By fourteen days the majority of inflammatory cells present were lymphocytes. Plasma cells comprised only a small proportion of the total number of inflammatory cells present at any time interval.

Histologic Evaluation

Both control and experimental sides at two days had fibrinopurulent exudate associated with the gingival crevice. The inflammation present in the connective tissue adjacent to the bone was forty percent cellular and sixty percent fibrin. On the control side mild inflammation was present within bone. On the experimental side four to five osteoclastic resorption lacunae were commonly seen on the buccal surface of the alveolar bone. Three foreign bodies were detected with polarized light in one dog, but no giant cells were present.

At four days fibrinopurulent exudate was still the common finding associated with the gingival crevice bilaterally. Two of the control areas had moderate inflammation in the connective tissue adjacent to the alveolar bone which was eighty-five percent fibrin and fifteen percent cellular. The third dog had minimal inflammation present. The experimental areas at four days were similar to those examined at two days, but the inflammation was reduced and only one osteoclastic resorption lacunae

was noted among the three dogs.

At seven days both sides had a mixture of chronic and acute inflammatory cells adjacent to the gingival crevice. Four to six osteoclastic resorption lacunae were seen along the buccal surface of alveolar bone. A few foreign bodies were detected on the control side in two dogs, but no foreign-body giant cells were associated with them. Inflammation was minimal in the connective tissue below the alveolar crest.

By fourteen days the control sides had a mixture of acute and chronic inflammatory cells associated with the gingival crevice, while the experimental sides had mild chronic inflammation adjacent to the crevice. Two or three osteoclastic resorption lacunae were commonly seen on both sides. Inflammation was essentially absent in the connective tissue below the alveolar crest. Figures 9 to 18 are photomicrographs which illustrate some of the histologic findings.

Part II: Placement of a Bolus of Powder

Clinical Evaluation

Two of three dogs sacrificed at two days had obvious ulceration and/or necrosis where the bolus of Prophy-Jet powder had been placed under the flap, the other was healing well. All dogs sacrificed at four days also had ulceration and partial necrosis of the flap. Only one of the three sacrificed at seven days had an ulcerated flap,

the others were healing well. Of the four animals sacrificed at fourteen days only one had an area of ulceration. Figures 19 to 21 illustrate some of the clinical results.

Histologic Evaluation

At two days a fibrinopurulent exudate was seen in the crevice and along the entire buccal surface of the alveolar bone. The overwhelming predominant cell type was the polymorphonuclear leukocyte. These findings were seen in all three dogs. One foreign body was seen in the connective tissue of one dog. Once again, no giant-cell response to this foreign body was seen.

The four-day specimens had evidence of acute inflammation in bone with extensive resorption. There was fibrinopurulent exudate seen associated with the crevice and above the alveolar crest. The predominant inflammatory cell type was the PMN leukocyte. One dog had evidence of microabscess formation in the tissue immediately adjacent to the area of sloughing and necrosis.

At seven days two specimens contained several foreign bodies which were detected with polarized light. Again, no giant cells were seen in association with these foreign bodies. The inflammation seen was predominantly chronic. The inflammation associated with the gingival crevice was varied ranging from a fibrinopurulent exudate to chronic cells. Mild inflammation within bone was observed in one dog.

Fig. 9. Photomicrograph of two-day experimental section (Part I). Inflammation is most pronounced lateral and coronal to the crestal bone. Original magnification is 40X.

Fig. 10. Higher magnification of the area in the box in Fig. 9. An acute inflammatory response with a predominance of PMN leukocytes is present. Original magnification is 400X.

Fig. 11. Two-day control section (Part I). Inflammation is mostly seen associated with the apical extent of flap reflection. Original magnification is 25X.

Fig. 12. Four-day experimental section (Part I). A vertical band composed of fibrin and acute inflammatory cells is apparent paralleling bone. Original magnification is 40X.

Fig. 13. Four-day control section (Part I). Extensive acute inflammation is noted adjacent to the bone in the coronal half of the field. Original magnification is 10X.

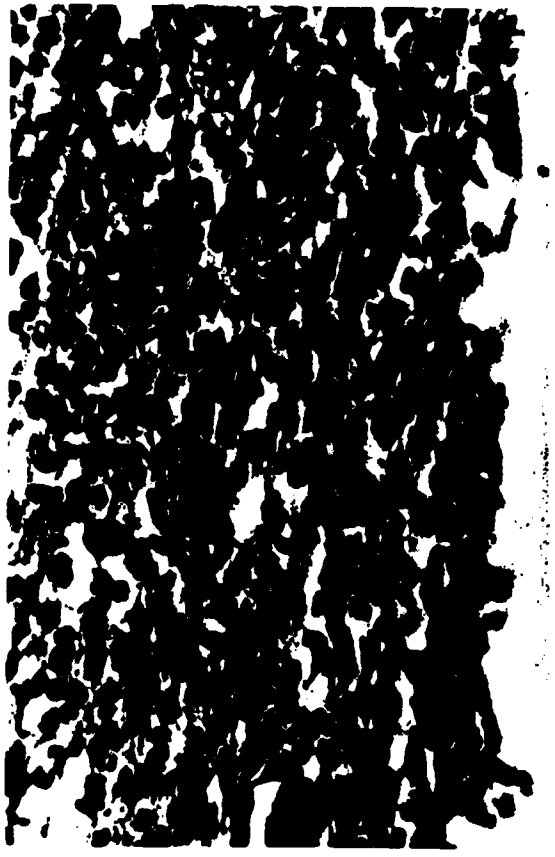

Fig. 14. Higher magnification of the area in the box in Fig. 13. A predominance of PMN leukocytes is evident. Original magnification is 400X.

Fig. 15. Seven-day control section (Part I). Inflammation is mild and mainly perivascular. Original magnification is 40X.

Fig. 16. Seven-day experimental section (Part I). Groove created in the root by the Prophy-Jet can be seen. Original magnification is 125X.

Fig. 17. Fourteen-day control section (Part I). Minimal inflammation is present and immature connective tissue is seen adjacent to the bone. Original magnification is 40X.

Fig. 18. Fourteen-day experimental section (Part I). Fibrosis and scattered chronic inflammation is present lateral to the bone. Supracrestal area is dominated by plasma cells. Original magnification is 40X.

Fig. 19. Clinical results seen in a two-day fo
(Part II).

Fig. 20. Clinical results seen in three four-day dogs (Part II).

Fig. 21. Clinical results seen in a fourteen-day dog (Part II).

At fourteen days the inflammation associated with the crevice was chronic in nature. Two to eight osteoclastic resorption lacunae were seen. Bone apposition was noted in one dog. The inflammation present in the connective tissue flap was minimal and predominantly chronic in nature with the exception of one dog in which the inflammation was acute. Figures 22 to 25 document some of the findings mentioned.

Part III: Spraying of the Soft Tissue Flap

Clinically all three areas which had the underside of the flap sprayed, showed delayed healing and erythema when compared to the control site. No areas of ulceration, necrosis, or recession were seen.

The two-day and four-day specimens had a fibrino-purulent exudate associated with the crevice and along the buccal surface of bone. A few osteoclastic resorptive lacunae were observed and moderate acute inflammation within bone was present. One foreign body was also noted in the two-day dog. The oral epithelium was missing on the four-day dog. The seven-day specimen was characterized by minimal chronic inflammation. There were several foreign bodies detected and a few osteoclastic lacunae observed in the buccal alveolar bone. Healing appeared to be progressing well by seven days. Figures 26 and 27 illustrate these findings.

Fig. 22. Photomicrograph of a two-day section (Part II). Extensive fibrinopurulent exudate is seen lateral to and paralleling the bone. Original magnification is 25X.

Fig. 23. Higher magnification of the area in the box in Fig. 22. Cellular infiltrate is composed mainly of PMN leukocytes. Original magnification is 400X.

Fig. 24. Photomicrograph of a four-day section (Part II). A linear band of fibrinopurulent exudate is present adjacent to and paralleling the bone. Original magnification is 25X.

Fig. 25. Fourteen-day section from Part II. Minimal inflammation is present lateral to the bone. Original magnification is 40X.

Fig. 26. Clinical results after four days (Part III).

Fig. 27. Photomicrograph of four-day section from the dog seen in Fig. 26. A predominance of fibrin is located adjacent to the bone. Original magnification is 25X.

DISCUSSION

The first part of this investigation was designed to expose the surgical area in a manner similar to that which would occur if the Prophy-Jet were used for root detoxification during periodontal flap surgery. The results indicate there were no detrimental effects on the healing of the periodontal tissues.

The histologic findings at both the control and experimental sites were consistent with normal healing and generally consistent with other reported results following the reflection of a full-thickness flap (Wilderman, 1964; Levin, et al., 1977). Their findings included: the presence of a fibrin clot at two days between the replaced flap and alveolar bone; osteoclastic resorptive activity reaching its peak at about seven days; and inflammation reaching a peak at two to four days then diminishing to minimal levels by fourteen days.

The results of the present study differ with those of previous studies regarding initiation of osteoclastic and osteoblastic activity. Wilderman (1964) did not begin to see surface resorption until day four, whereas it was seen at two days in the present study. Wilderman (1964) reported bone apposition beginning at day ten and Levin et al. (1977) reported seeing evidence of bone apposition by day fourteen. Little or no evidence of bone apposition was

observed by day fourteen in the present study. These differences are probably a result of different predetermined sacrifice times as well as small sample sizes.

The histologic findings at both the control and experimental sites were very similar with the exception of two animals in the four day group. The reason for the differences seen in this group is not known. Although the control sites at four days had significantly more inflammation present, the differences were thought to be clinically insignificant as all sites were judged to be healing within normal limits.

The normal inflammatory response after periodontal flap surgery would be for the amount of inflammation to peak at two to four days post-operatively at which time the polymorphonuclear leukocyte would be the predominant cell type. As the overall inflammation diminished with time, so would the relative presence of the PMN leukocytes (Levin et al., 1977). This is exactly the pattern observed in Part I of the present study.

The second part of this investigation was designed to examine the effects of a localized accumulation of the Prophy-Jet powder under a periodontal flap. The accumulation of forty milligrams of powder over an area of two square centimeters is an improbable occurrence after the use of the Prophy-Jet. This amount was chosen in order to see if such a localized concentration of the powder could

be tolerated by the periodontal tissues. The results indicate that such a localized concentration of the Prophy-Jet powder is not well tolerated. Seven of the thirteen dogs had clinical evidence of ulceration and necrosis of that portion of the flap immediately overlying the bolus of powder. The histologic examination revealed an extensive inflammatory response in most specimens, especially those which demonstrated ulceration clinically.

It was the impression of this investigator that the bolus of powder was almost, if not entirely, dissolved within five minutes after placement. Since there was very little bleeding at the surgical site when the bolus was placed, it may be concluded that extracellular and intracellular fluid was the solvent. It is probable, therefore, that the dissolution of the powder altered the osmotic pressure and resulted in the dessication of cells. The sodium bicarbonate in solution also may elevate the pH of the fluids. It is not clear what effect, if any, this may have had on the subsequent healing.

The final part of this investigation was designed to examine the effects which may result from inadvertent spraying of the underside of the flap. Only three dogs were used but the results were consistent. Clincially the tissues appeared erythematous and traumatized, especially at two and four days. These results were consistent with the previous investigation by Clinical Research Associates

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(1981) in which the external gingival surfaces were sprayed with the Prophy-Jet. They reported extensive soft tissue damage initially, but complete healing by fifteen days.

Foreign bodies were occasionally seen in sections from all three parts of this investigation. These foreign bodies did refract polarized light. The Prophy-Jet powder was examined microscopically and with polarized light. The foreign bodies seen in the sections did not resemble the Prophy-Jet powder. It is possible these foreign bodies could have been undissolved calcium phosphate tribasic, however that could not account for similar foreign bodies seen in some of the control specimens. The foreign bodies did not resemble starch or talc granules from surgical gloves. Whatever the source of these foreign bodies, the important point is that no foreign body giant cell reaction was elicited.

The results of this investigation may serve as the basis for further studies. Future areas of investigation might include: the evaluation of the Prophy-Jet detoxifying ability in vivo; the evaluation of the soft tissue attachment to roots treated with the Prophy-Jet; the pulpal response to the use of the Prophy-Jet on root surfaces; or possible effects of using the Prophy-Jet followed by citric acid application.

While the results of this research are promising, human studies are necessary before the use of the

Prophy-Jet in periodontal surgery can be recommended. If such studies of the Prophy-Jet's potential use in surgery are undertaken with human subjects, the following recommendations are offered:

1. Avoid direct spraying of the soft tissues and where possible protect the tissues by retraction or by covering.

2. Generous irrigation should be used to avoid localized accumulations of the Prophy-Jet powder.

3. The clinician should be mindful of how abrasive the Prophy-Jet can be to root surfaces.

4. Thin radicular bone should be protected from the spray.

5. Care should be exercised to avoid forcing air under the flaps and along fascial planes.

CONCLUSIONS

This research has shown the following in dogs:

1. Utilization of the Prophy-Jet for root detoxification during periodontal surgery, if used with reasonable caution, does not have any clinical or histological adverse effects on the healing of the periodontal tissues.

2. The localized placement of 40 milligrams of Prophy-Jet powder under a periodontal full-thickness flap results in ulceration and necrosis of a portion of the flap in over half of the specimens and histologic evidence of increased inflammation and osteoclastic activity in the majority of the specimens.

3. If the underside of a periodontal flap is sprayed directly with the Prophy-Jet for five seconds at a distance of six millimeters, subsequent healing is delayed and there is clinical evidence of trauma to the tissues for at least seven days post-operatively.

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